Supporting Information

Degradation and Mineralization of Carbamazepine Using an Electro-Fenton Reaction Catalyzed by Magnetite Nanoparticles Fixed on an Electrocatalytic Carbon Fiber Textile Cathode

Kai Liu,[†] Joseph Che-Chin Yu,[†,‡] Heng Dong,[†] Jeffrey C. S. Wu,[‡] Michael R. Hoffmann[†,*]

[†]Department of Environmental Science and Engineering, California Institute of Technology, Pasadena, California 91126, United States

[‡] Department of Chemical Engineering, National Taiwan University, Taipei 10617, Taiwan

Summary:

Pages: 10

Tables: 3

Figures: 18

Table S1. Carbon, oxygen, and nitrogen contents (%) of CNF and FeCNF1 obtained from XPS elemental analysis.

Sample	C	O	N
CNF	82.40	7.93	9.67
FeCNF1	83.14	11.70	5.15

Table S2. Elemental composition of the samples.

Sample	Major element composition (wt %)		
	C	O	Fe
FeCNF0.1	90.69	9.31	below detection limit
FeCNF0.3	91.60	8.05	0.36
FeCNF0.5	90.03	8.91	1.06
FeCNF1	88.86	9.34	1.79
FeCNF5	85.31	5.49	9.20

Table S3. Pesudo-first-order rate constant and square regression coefficient for electro-Fenton degradation of carbamazepine (C_0 = 1ppm).

Sample	Reaction conditions		K_{app} (h^{-1})	r^2
	potential (V)	electrolyte pH		
FeCNF0.05	-0.345	7	1.79	0.970
FeCNF0.1	-0.345	7	6.85	0.988
FeCNF0.3	-0.345	7	2.43	0.986
FeCNF0.5	-0.345	7	1.35	0.979
FeCNF1	-0.345	7	0.52	0.988
FeCNF0.1	-0.345	4	4.78	0.990
FeCNF0.1	-0.345	10	3.30	0.997
FeCNF0.1	-0.145	7	4.81	0.985
FeCNF0.1	-0.545	7	9.00	0.989

Figure S1. SEM-EDS elemental analysis of grinded (a) FeCNF0.1, (b) FeCNF0.3, (c) FeCNF0.5, (d) FeCNF1, and (e) FeCNF5.

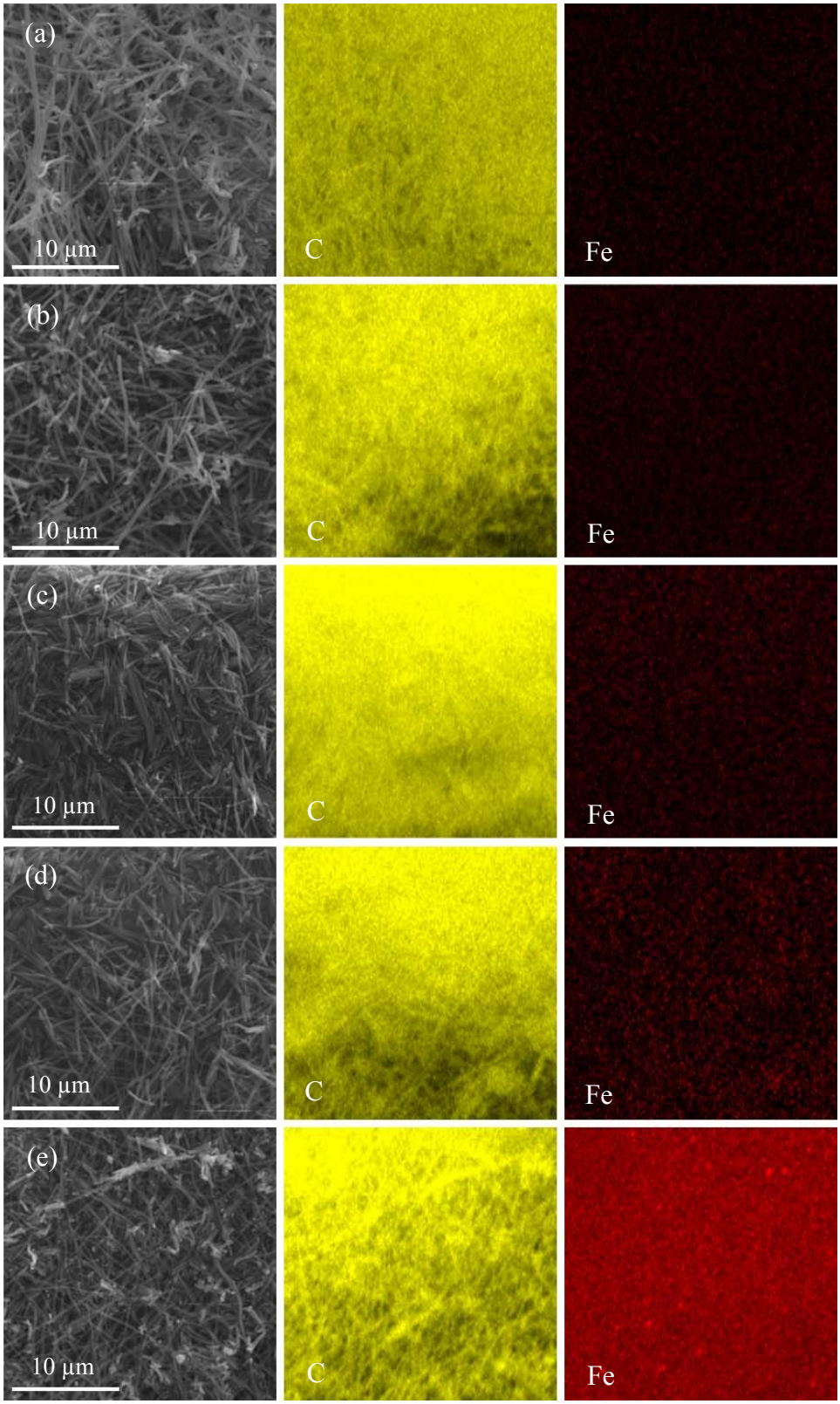


Figure S2. TEM images of FeCNF1 at different magnification.

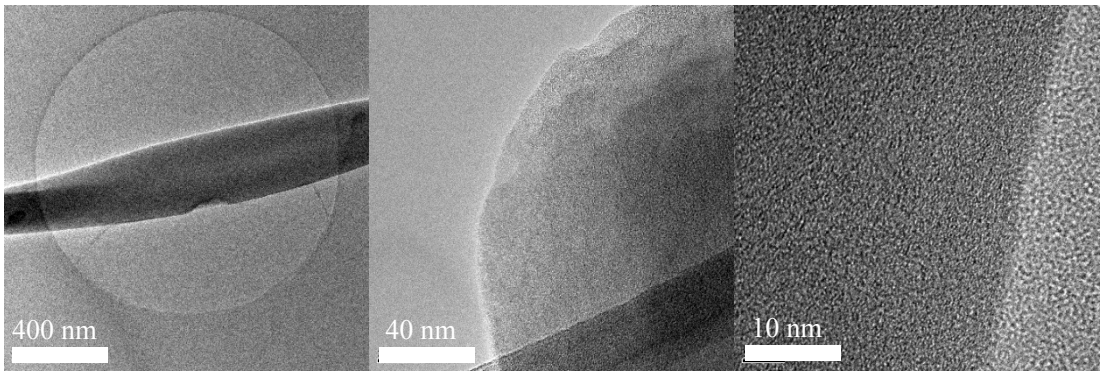


Figure S3. TEM images of FeCNF1 and TEM-EDS mapping for C, Fe elements.

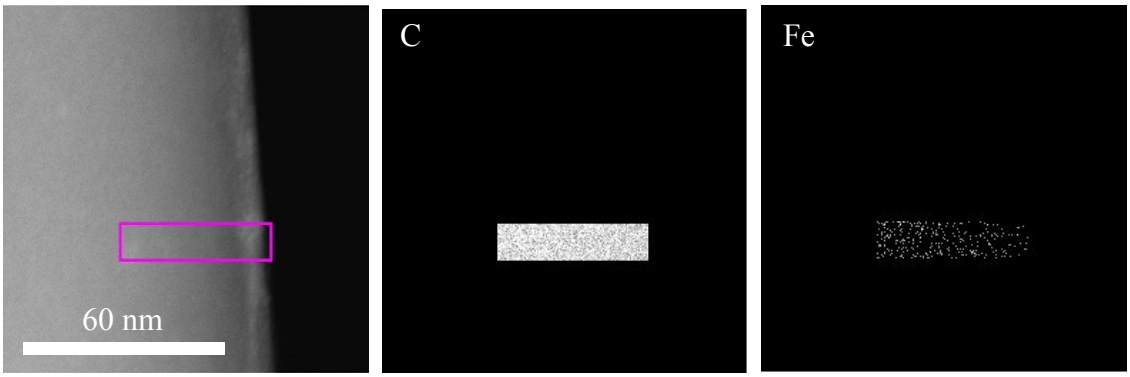


Figure S4. PXRD spectrum of Fe_3O_4-NP@CNF, CNF, and calculated Fe_3O_4.

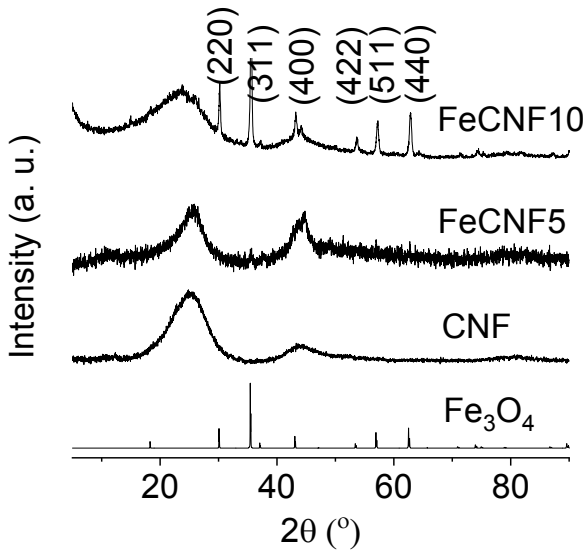


Figure S5. XPS survey spectrum of CNF (left) and FeCNF1 (right).

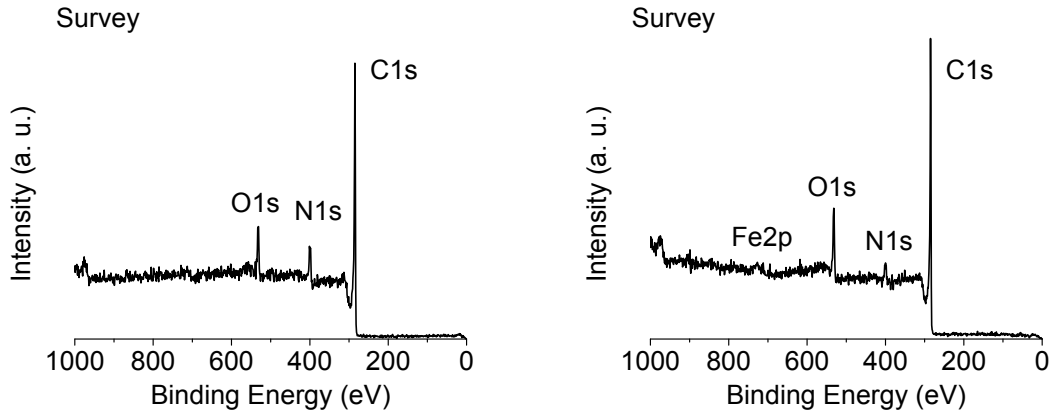


Figure S6. High resolution XPS spectrum of CNF.

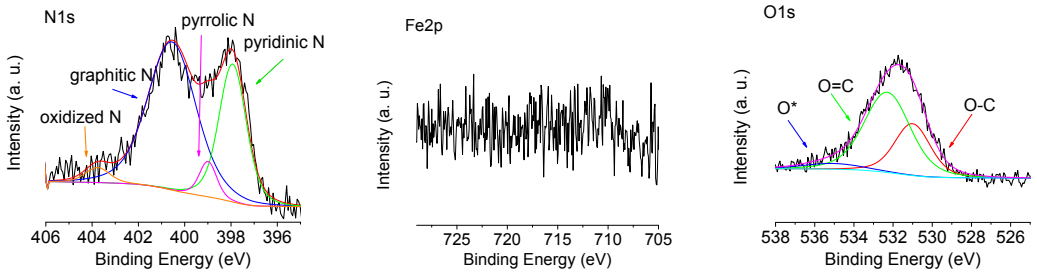


Figure S7. High resolution XPS spectrum of FeCNF1.

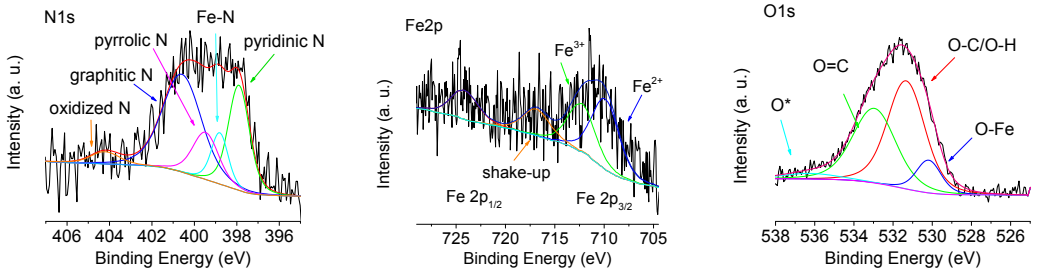


Figure S8. Kinetics of carbamazepine removal at pH 7 by (a) electrosorption on CNF and (b) electro-Fenton (FeCNF0.1, -0.345 V) and H_2O_2 degradation.

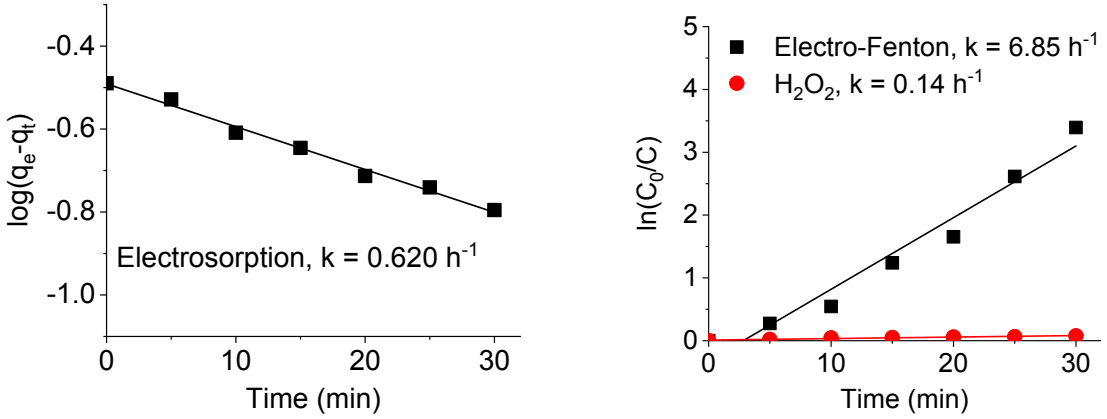


Figure S9. Kinetics of carbamazepine removal by electro-Fenton process using Fe_3O_4@CNF electrodes at pH 7.

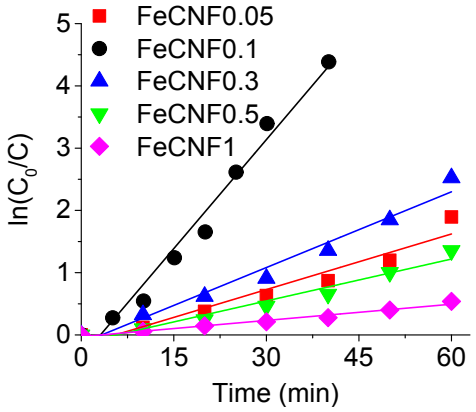


Figure S10. Electrolyte pH effect on electro-Fenton removal efficiency of carbamazepine (FeCNF0.1, -0.345 V).

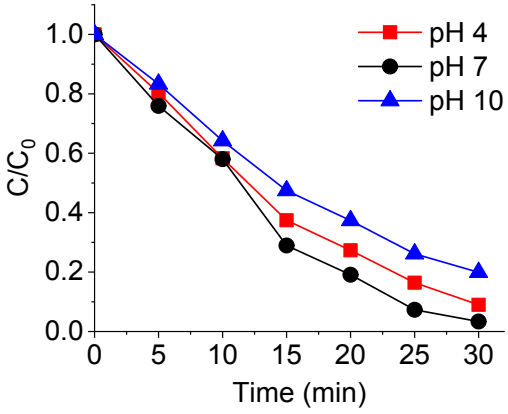


Figure S11. pH effects on carbamazepine removal kinetics by electro-Fenton process using Fe_3O_4@CNF electrodes (FeCNF0.1, -0.345 V).

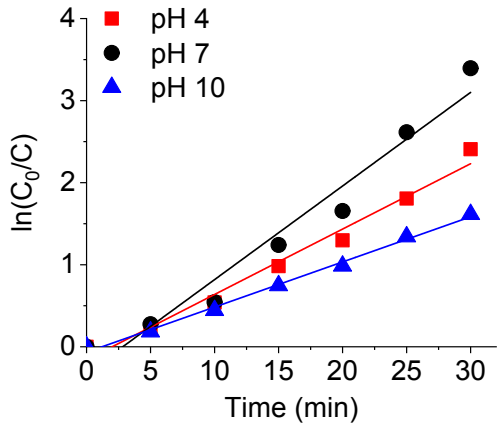


Figure S12. Potential effect on electro-Fenton removal efficiency of carbamazepine (FeCNF0.1, -0.345 V).

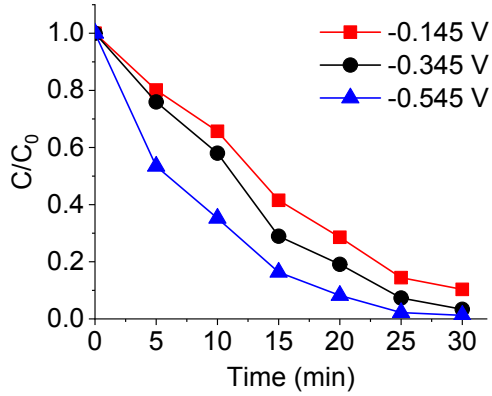


Figure S13. Potential effects on carbamazepine removal kinetics by electro-Fenton process using Fe_3O_4@CNF electrodes (FeCNF0.1, pH 7).

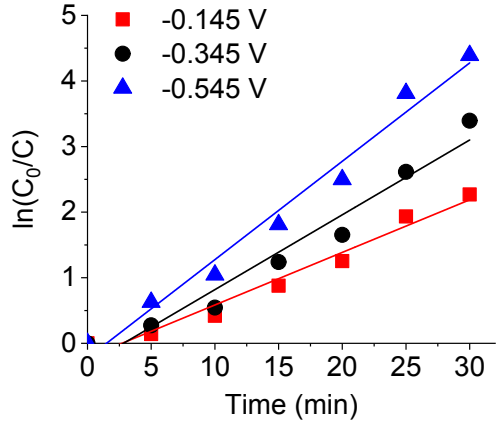


Figure S14. Effect of Fe_3O_4 doping concentration on TPA probe removal rate (-0.345 V, pH 7).

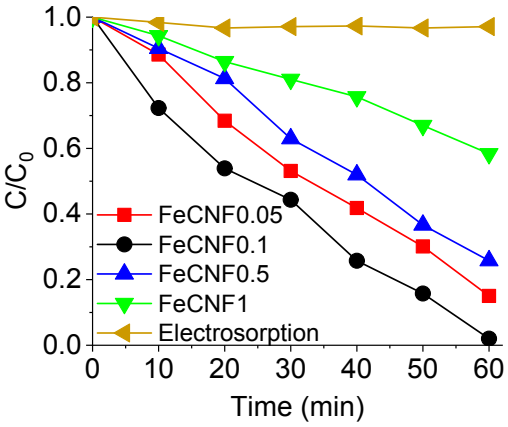


Figure S15. Effect of Fe_3O_4 doping concentration on TPA probe removal rate (FeCNF0.1, -0.345 V, pH 7).

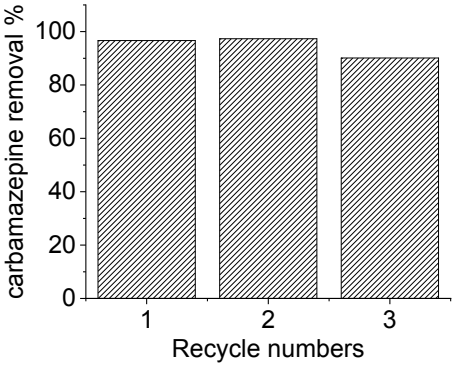


Figure S16. CV curves of FeCNF0.01 (left), FeCNF0.1 (middle), and FeCNF1 (right) at pH 7 with a scan rate of 10 mV/s.

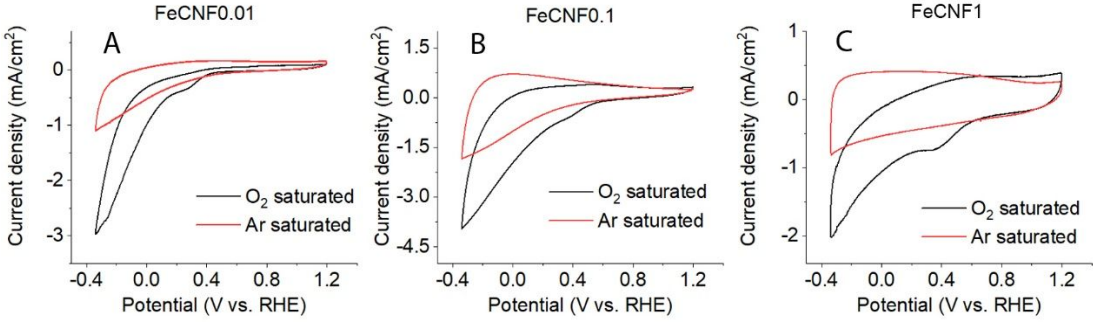


Figure S17. Intermediates detected during the electro-Fenton degradation of carbamazepine.

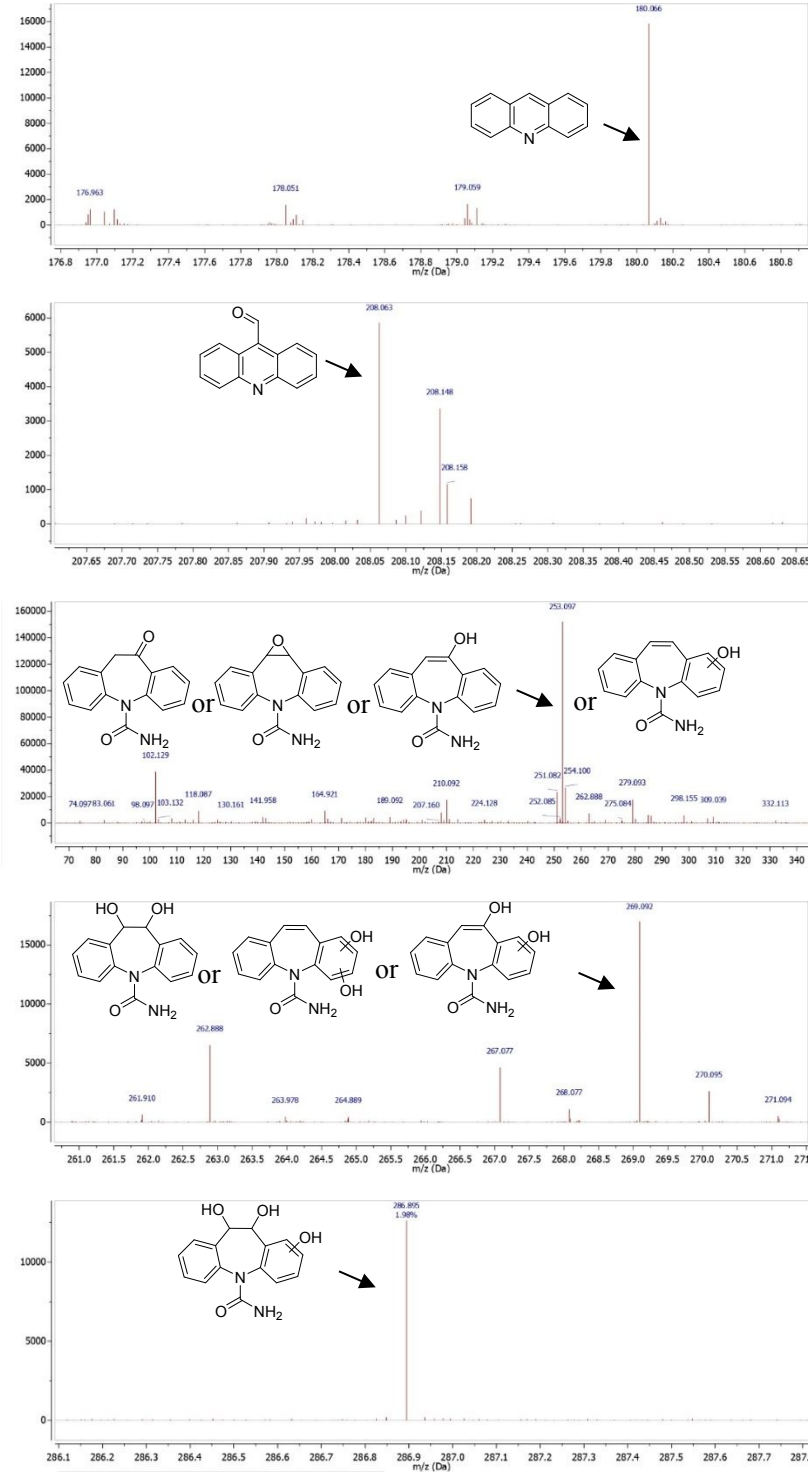
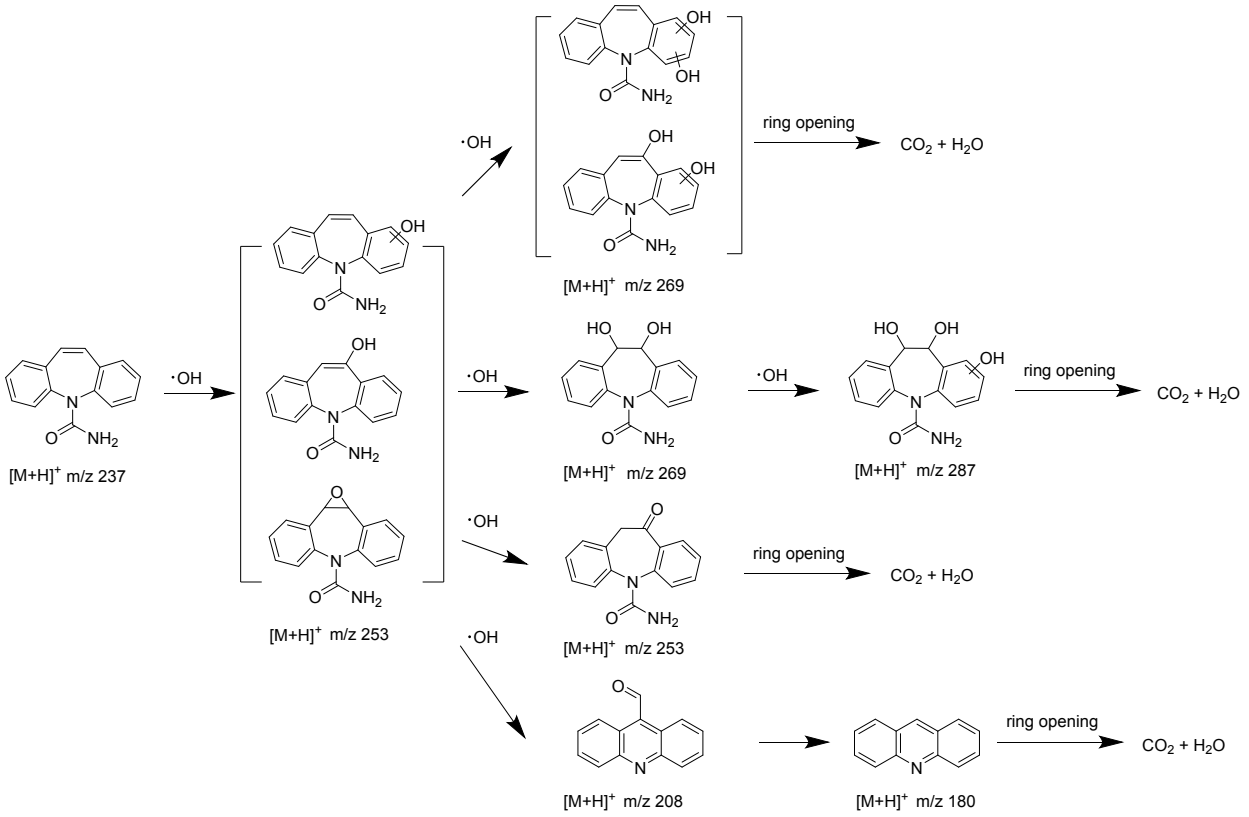
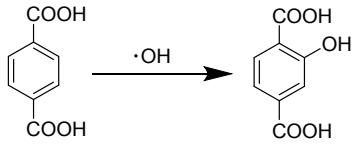


Figure S18. Proposed degradation pathway for carbamazepine in the electro-Fenton process.



·OH Measurement

Terephthalic acid (TPA) reacts with hydroxyl radical (·OH) to generate hydroxylterephthalic acid (HTPA) through the following reaction:



(eq S1)

The concentration of ·OH can be determined by monitoring the TPA concentration:

$$[\cdot OH] = [TPA]_{initial} - [TPA]_{final} \qquad \text{(eq S2)}$$